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PENSOFT

First record of *Jupiaba acanthogaster* (Eigenmann, 1911) (Ostariophysi, Characidae) in the upper Paraná river basin, Brazil

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Abstract
Jupiaba Zanata, 1997 is a genus with small species within Characidae, identified by a pair of modified bones in the form of spines just anteriorly to pelvic-fin base. The genus is mostly distributed throughout the Amazon drainage, except *J. acanthogaster* (Eigenmann, 1911), which also occurs in the Paraguay river basin. In this work, we recorded for the first time *J. acanthogaster* in the Sucuriú River drainage, upper Paraná river basin, Brazil. Its occurrence may be a consequence of the historical hydrological interaction between the Paraná and Paraguay river basins.

Keywords
Characiformes, headwater catchments, species distribution, Sucuriú river basin.

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Introduction

Jupiaba Zanata, 1997 was described to host small species of Characidae that has, among other characteristics, pelvic bones modified in the form of spines. Many species currently classified in *Jupiaba* were described in *Astyanax* Baird & Girard, 1854 (e.g. Eigenmann 1909) or *Deuterodon* Eigenmann, 1907 (e.g. Eigenmann 1911) (Zanata 1997). The representatives of the genus are mostly from the Amazon river basin, with some species occurring throughout the Tocantins–Araguaia, Orinoco, Parnaíba, Paraguay and coastal river basins of Guyana (van der Sleen and Lima 2018; Dagosta and De Pinna 2019).

Jupiaba acanthogaster (Eigenmann 1911) was described from the upper Paraguay river basin and also occurs in the Amazon river basin (Zanata 1997; Ribeiro et al. 2013). It is a rheophilic species, with distribution restricted to the plateau areas of both basins, suggesting a recent separation of these populations by the formation of the Pantanal floodplain, which changed the course of several South American rivers and isolated populations within the headwater regions of these drainages (Ribeiro et al. 2013).

Similar geological processes that shaped modern river courses are recognized for the interface areas of several Neotropical river basins and are pointed out as one of the possible causes for species sharing between neighbouring drainages. Ribeiro et al. (2011) commented that seismic rearrangement events occurs in many

regions of the South American, in continental scale, causing capture headwaters and share of fauna in these regions. This occurs between the basins of the upper Paraná and Ribeira de Iguape (Frota et al. 2019), Paraná–Tocantins–São Francisco (Aquino and Colli 2017), and Paraguay and Amazonas (Birindelli and Britski 2009; Ribeiro et al. 2011; Ribeiro et al. 2013).

The sharing of species between the upper Paraguay river basin and the upper Paraná river basin is well documented (Langeani et al. 2007; Costa-Silva et al. 2017; Froehlich et al. 2017; Ota et al. 2018). An example includes *Planaltina myersi* Böhlke, 1954, a rheophilic Stevardiinae that is restricted to plateau streams of the upper Paraná river basin, and which was also recorded in the upper Paraguay river basin (Menezes et al. 2003). This is likely due to headwater catchment events between these river basins, as the geological dividers of Paraná–Paraguay basin occur at several points in areas of tectonic deformations, causing potential rearrangements in the course of the headwater streams (Ribeiro et al. 2011).

Other examples of shared species in headwaters streams of the Paraná–Paraguay river basins were previously documented, such as *Oligosarcus pintoi* Amaral-Campos, 1945 and *Phenacorhamdia tenebrosa* (Schubart, 1964), both historically known from the upper Paraná River and recorded at upper Paraguay River (Valério et al. 2007). Additionally, *Astyanax lineatus* (Perugia, 1891), originally described from the upper Paraguay river basin and registered in the upper Paraná river basin by Ferreira et al. (2017), was found in plateau areas and along the limits of these drainages.

However, some species shared between the Paraguay river basin and the upper Paraná river basin are result of anthropogenic activity, including the introduction of species used as bait for fishing, activities related to fish-farming, the aquarium hobby, or the destruction of natural biogeographic barriers. One example of species introduction in the upper Paraná River was the impoundment of the Sete Quedas waterfalls, which separates the regions of the upper Paraná river basin and lower Paraná river basin, which presents an ichthyofauna similar to that of the Paraguay river basin (Langeani et al. 2007; Froehlich et al. 2017; Ota et al. 2018).

In this work, we provide the first record of *Jupiaba acanthogaster* in the upper Paraná river basin, located in a headwater region near to the upper Paraguay river basin. We also examine the possible causes of this occurrence outside the Amazonian drainage and the Paraguay River.

Methods

Specimens were collected in 6 September 2018, in the córrego Indaiá, near a wooden bridge, located on an access road to a sugar cane plantation. The samples were performed with trawl with 10 × 10 mm mesh. The collection was authorized by the National System of Biodiversity Information (permit #402616/2018). All individuals are deposited in the Zoological Reference Collection of the Federal University of Mato Grosso do Sul (ZUFMS). Identification was confirmed by the authors based on the original description (Eigenmann 1911) and the redescription of the species in Zanata (1997). Measurements and counts were performed in 12 individuals according to Fink and Weitzman (1974), using a digital calliper, point-to-point, on the left side of the specimens whenever possible, and with an approximation of tenths of millimetres.

Results

***Jupiaba acanthogaster* (Eigenmann, 1911)**
Figures 1, 2; Table 1

New record. BRAZIL • 12 undetermined sex, 33.4–39.9 mm; Mato Grosso do Sul, Costa Rica municipality, córrego Indaiá, affluent of Sucuriú River, upper Paraná river basin; 18°25.39′S, 053°09.32′W; alt. 665 m; 6 Sept. 2018; TTM Taveira, DA Lopes leg.; ZUFMS 5778.

Identification. *Jupiaba acanthogaster* can be recognized by having the following features: (I) a pair of bony spines facing forward at the anterior portion of the pelvic fin; (II) five premaxillary teeth with cusps very similar in shape and size; (III) eight teeth in the dentary that gradually decrease in size from anterior to posterior; (IV) third infraorbital in ventral contact with preopercle; (V) mid caudal-fin rays blackened to the end; (VI) conspicuous and vertically elongated humeral spot; (VII) anal fin with iv, 19–23 rays; and (VIII) lateral line with 35–38 perforated scales (Eigenmann 1911; Zanata 1997).

Specimens of *J. acanthogaster* from the córrego Indaiá (Fig. 2) present very similar premaxillar teeth, eight dentary teeth decreasing in size posteriorly, the median caudal rays blackened, black lateral band anterior to caudal fin, conspicuous humeral spot, and the following measurements and counts: iv, 20–22 rays in the anal fin, and 35–37 perforated scales in the lateral line. Other measures are presented in Table 1.

Discussion

Jupiaba acanthogaster (Eigenmann, 1911) was described based in 17 specimens collected by John D. Haseman that are deposited in the collections of the California Academy of Sciences (CAS), Carnegie Museum (CM), and Field Museum of Natural History (FMNH): 12 from Corumbá, in 27 April 1909 (holotype, FMNH 54748, ex CM 3395a; nine paratypes, FMNH 54749; and three paratypes, CAS 44255 ex CM 3395 b-l), and five from Rio Jauru, in 3 June 1909 (five paratypes, FMNH 54750, ex CM 3396). Haseman and Eigenmann (1911) described these localities in more detail, explaining that Haseman collected in the "Urucum Mountains, 25 miles back of Corumba, Matto Grosso [*sic*]" from 27 April to 2 May 1909, and that on 3 June 1909, Haseman was in "Campos Alegre, rio Jauru, into Rio Paraguay [sic]". Campos Alegre is probably a community located in a farm near

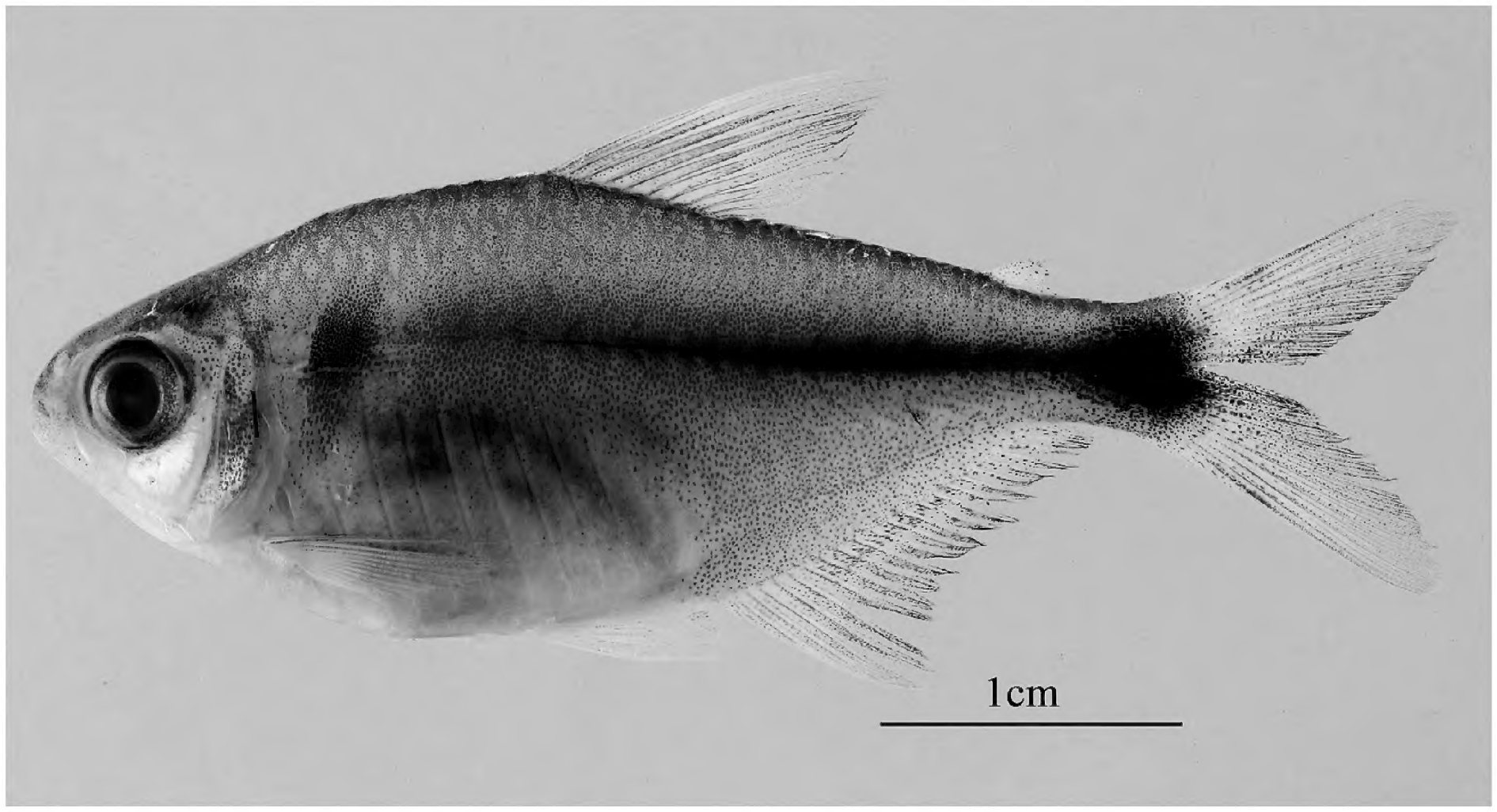

Figure 1. *Jupiaba acanthogaster* from Indaiá stream, Sucuriú drainage, upper Paraná river basin, Brazil (ZUFMS 05778, 39.9 mm SL).

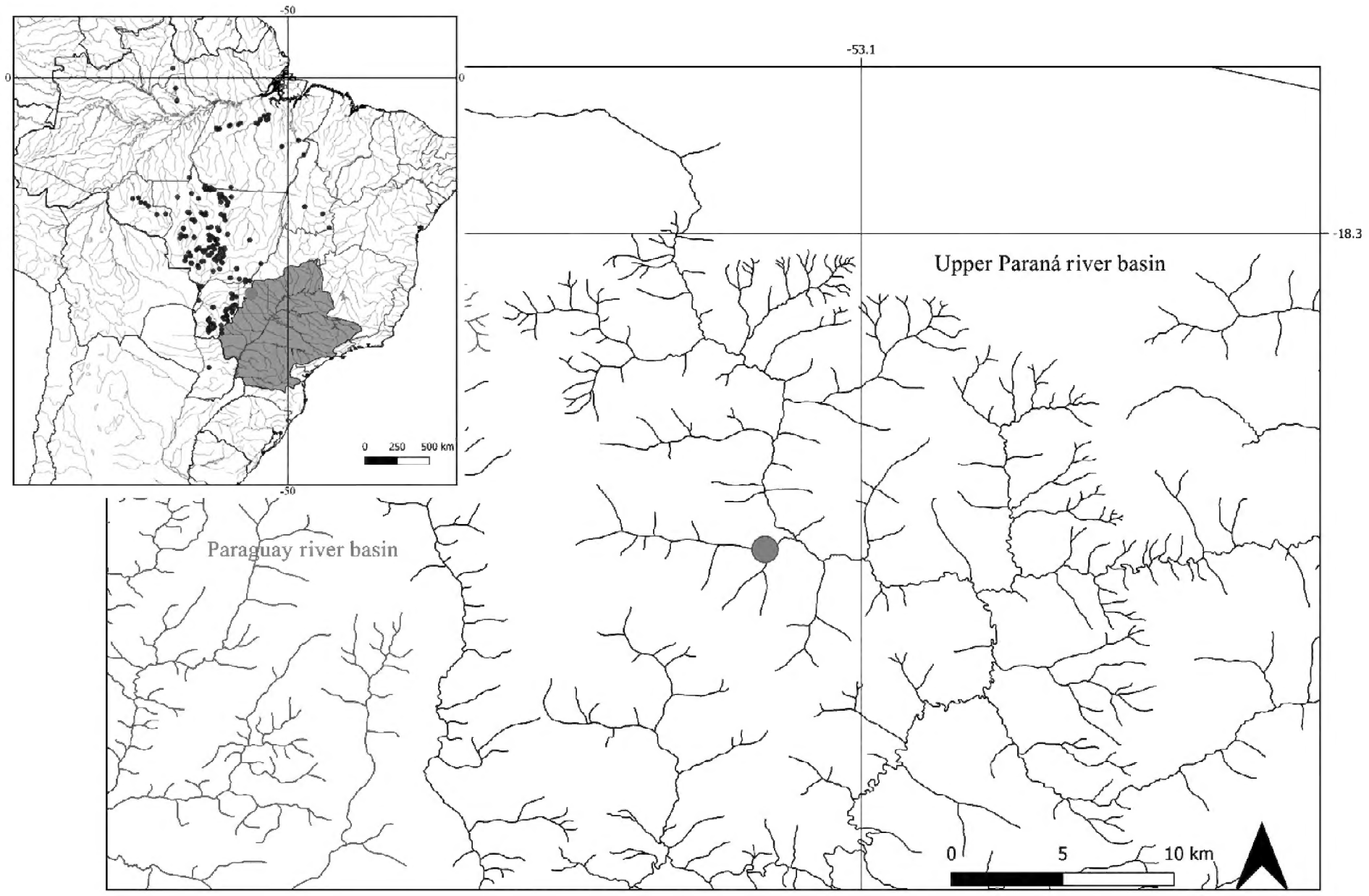

Figure 2. Known distribution in the Neotropical region (black circles) and new record (red circle) of *Jupiaba acanthogaster* in the upper Paraná river basin, Brazil.

Rio Jauru, in Cáceres, Mato Grosso state (Carniello 2007).

Jupiaba acanthogaster is currently known from the upper Paraguay river basin and from Amazon river basin (Ribeiro et al. 2013). The sharing of this species between these river basins is attributed to the tectonic movements that formed the Pantanal floodplain, as well as recent geological deformations, responsible for rearrangements of the headwater areas of the watershed (Ribeiro et al. 2011). This geological phenomenon generated the separation of lineages (by recent vicarious processes) of *J. acanthogaster* from other species that are now limited to high altitude environments of the river basins (Ribeiro et al. 2013).

Some borders of the upper Paraguay river basin with

Table 1. Morphometric data of *Jupiaba acanthogaster* specimens collected in the córrego Indaiá, upper Paraná river basin, Brazil (*N* = 12). SD = standard deviation of averages.

Measures	Range	Mean	SD
Standard length (mm)	33.4–39.9	35.8	—
Percents of standard length			
Body depth	33.9–37.8	35.9	1.3
Head length	21.4–24.4	23.0	0.7
Head depth	20.8–22.9	22.2	0.7
Predorsal length	44.7–50.8	48.1	1.8
Prepelvic length	39.0–48.3	46.4	2.1
Preanal length	61.2–64.9	63.2	1.2
Caudal peduncle depth	7.6–9.3	8.6	0.6
Dorsal-fin base length	14.4–16.3	15.4	0.6
Anal-fin base length	27.7–32.7	30.3	1.5
Pectoral-fin length	19.7–23.1	21.4	1.2
Pelvic-fin length	13.3–19.0	17.4	1.4
Dorsal-fin length	27.2–33.8	30.8	1.9
Anal-fin length	16.7–19.6	18.2	1.1
Caudal peduncle length	8.6–10.8	9.6	0.6
Dorsal-fin to adipose-fin distance	37.1–40.1	39.1	0.9
Eye to dorsal-fin origin	31.0–36.0	34.1	1.5
Dorsal origin to caudal origin	54.1–58.5	56.4	1.3
Percents of head length			
Interorbital width	29.9–37.8	34.3	2.0
Snout length	24.7–31.0	28.1	1.7
Orbital diamenter	33.4–40.0	45.5	2.1
Upper jaw length	24.2–29.2	26.4	1.6

other drainages, especially the upper Paraná river basin, still undergo seismic rearrangements, allowing the exchange of species and fragmentation of populations, among other phenomena (Menezes et al. 2008). The new record of *J. acanthogaster* in the Sucuriú River drainage, upper Paraná river basin, is close to the Taquari river basin, a watershed of the upper Paraguay river basin in which this species is common (LFC Tencatt pers. comm.).

This hypothesis of species sharing among headwater catchments between the Paraná–Paraguay river basins is corroborated in DNA-barcoding analyses (Costa-Silva et al. 2017). Some species, such as *Pyrrhulina australis* Eigenmann & Kennedy, 1903 and *Iheringichthys labrosus* (Lütken, 1874), have populations in both river basins, with high genetic variations but just one operational taxonomic unit. This fact reinforces the hypothesis that some species can be shared between these drainages due to relatively recent geological events, and that the time of insulation among the populations has not yet been sufficient for speciation to occur (Costa-Silva et al. 2017).

Thus, the first record of *J. acanthogaster* in the upper Paraná river basin extends this species' geographical distribution. We suggest that this occurrence is due to recent events of headwater catchment and to the proximity of the headwaters of both basins.

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Author's contribution

DAL and TTMT collected and identified the specimens; FSN produced the photograph and the map; FRC confirmed IDs and provided diagnosis and historical information about the species; DAL and FRC wrote the text.

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